(12) UK Patent Application (19) GB (11) 2 138 202 A

(43) Application published 17 Oct 1984

(21) Application No **8402889**

(22) Date of filing **3 Feb 1984**

(30) Priority data

(31) **465933** (32) **14 Feb 1983** (33) **US**

(71) Applicant
General Electric Company (USA-New York),
1 River Road, Schenectady, New York 12305,
United States of America

(72) Inventor
Jack Mack Strok

(74) Agent and/or Address for Service
Paul M. Turner,
47 Marylebone Lane, London W1M 6DL

(51) INT CL^3
H01J 61/26

(52) Domestic classification
H1D 12B13Y 12B1 12B2 12B47Y 12B4 12C 12G 35 5P3 9B 9D 9Y
U1S 1932 H1D

(56) Documents cited

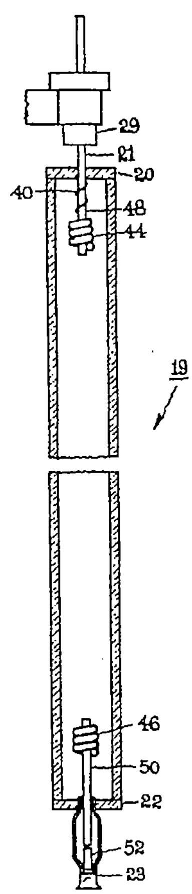
GB A 2125615	GB 1211176
GB 1564941	GB 0698840
GB 1514467	US 3558963
GB 1240778	US 3485343

(58) Field of search
H1D

(54) Discharge lamp

(57) A high pressure sodium lamp (10) having improved color rendition has an inner arc tube (13) having a pair of thermionic electrodes (46,48) at least one of which has affixed thereto a metallic oxygen getter consisting of a metal selected from the group of zirconium, vanadium, titanium, yttrium and thorium metals, and alloys thereof excluding yttrium. The getter may be in the form of a wire 40 wound around one or both of the electrode shanks. Alternatively, where the arc tube includes a niobium reservoir tube 23, the getter 52 may be located therein and of wire-like or sheet roll form.

Fig. 3



GB 2 138 202 A

Fig. 1

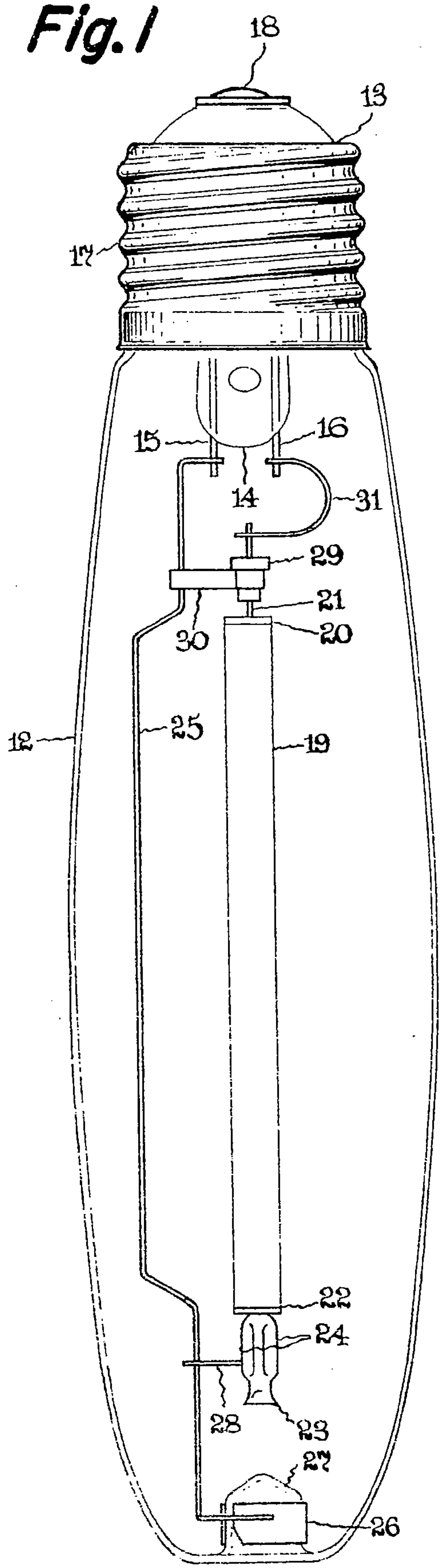


Fig. 2

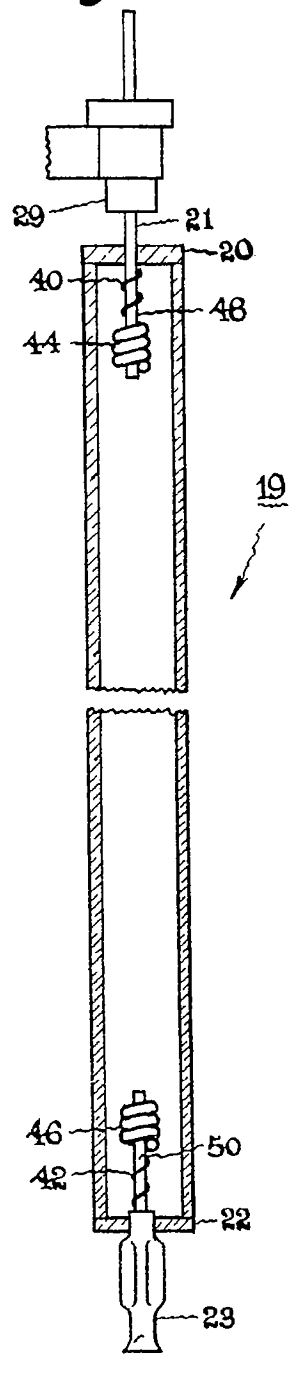


Fig. 3

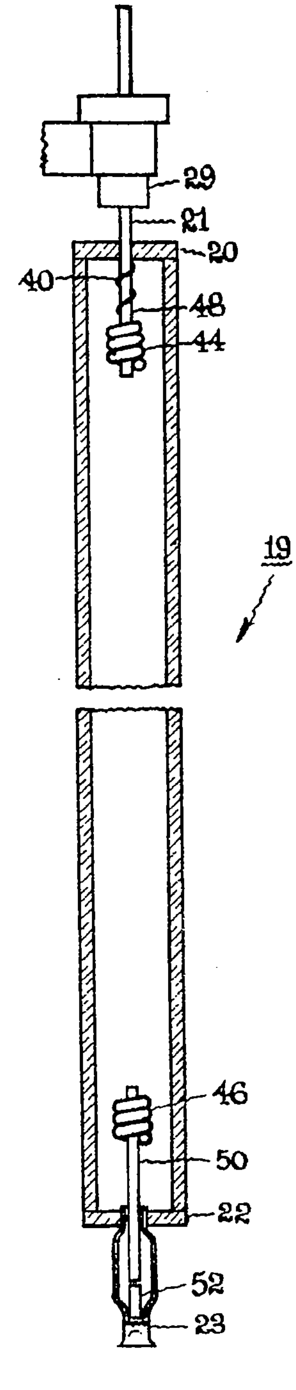


Fig. 4

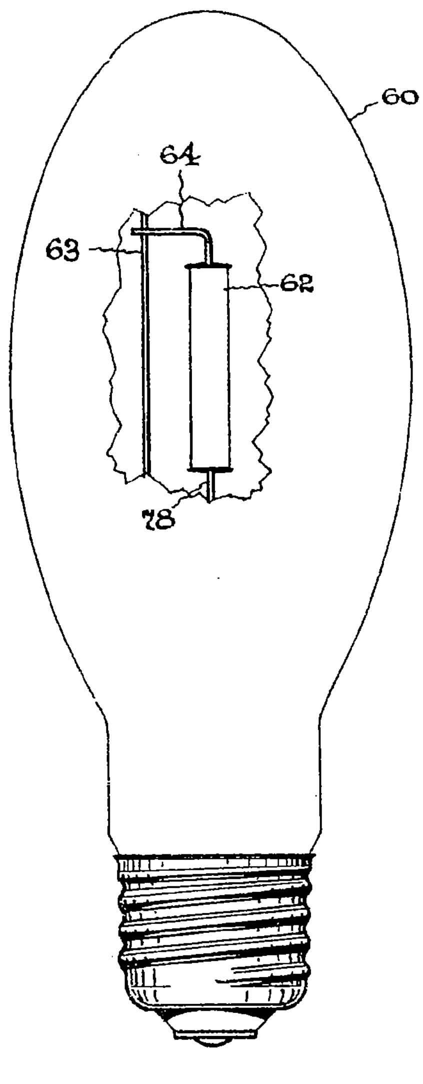
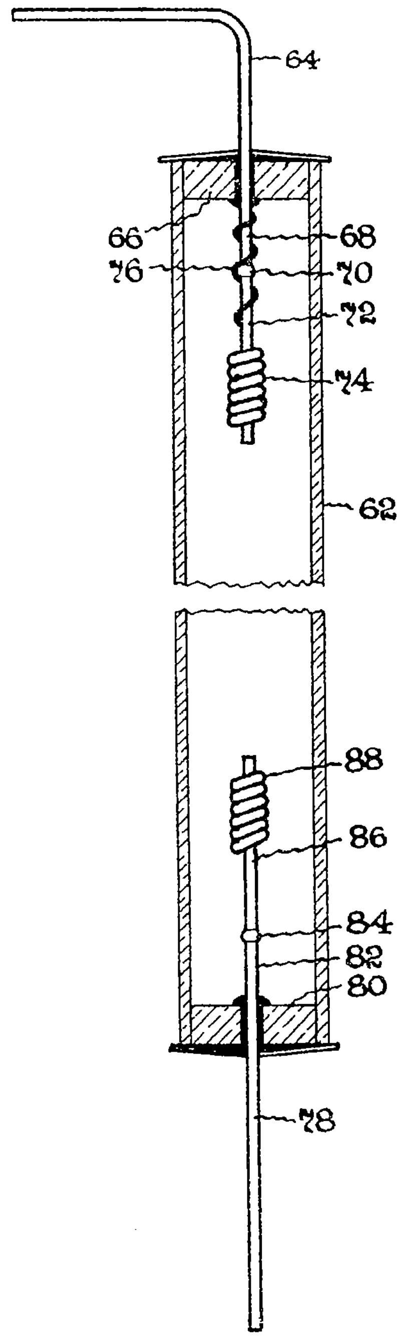
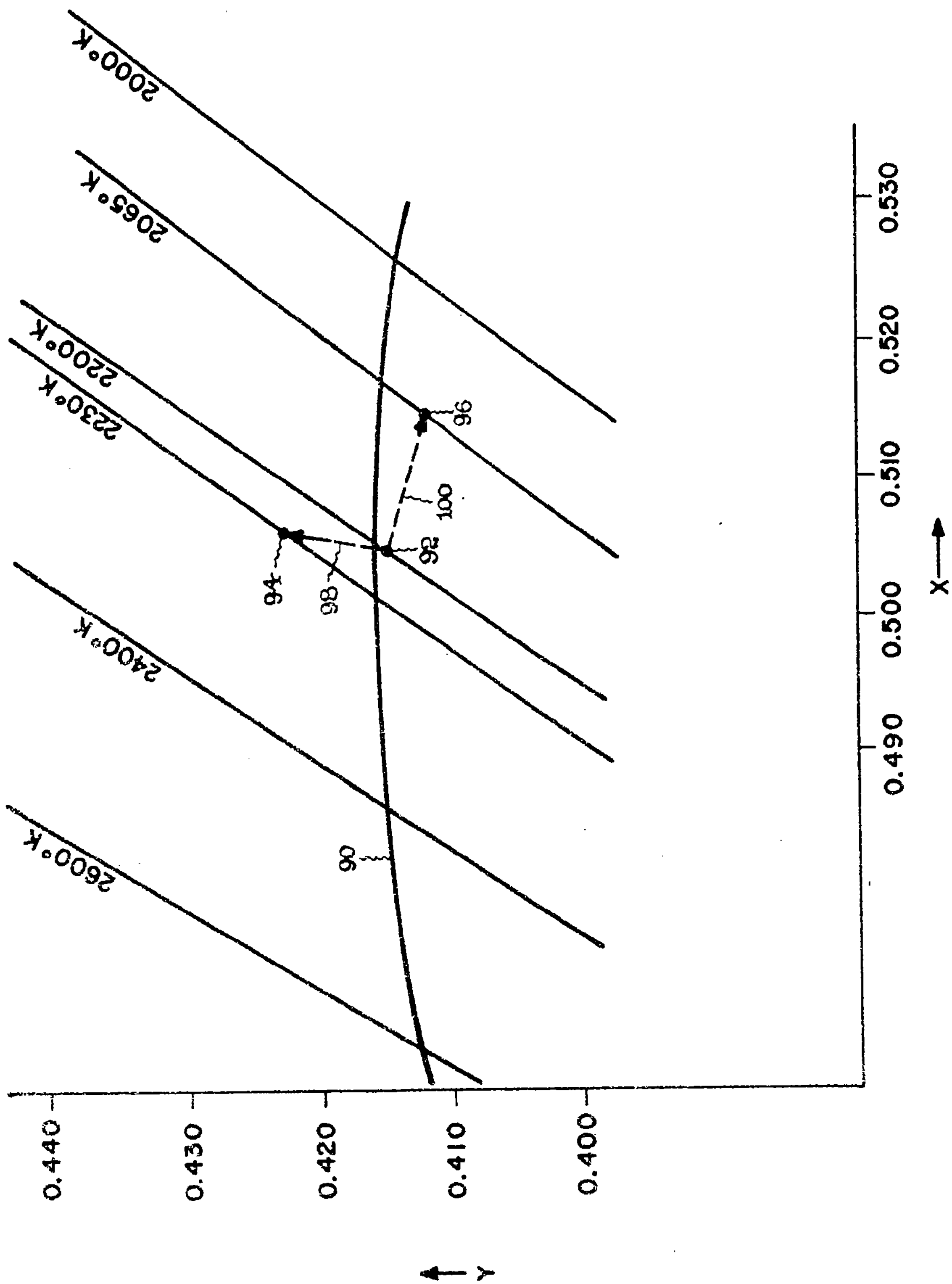


Fig. 5





2000°K
2065°K
2200°K
2230°K
2400°K
2600°K
90
92
94
96
98
100
0.490
0.500
0.510
0.520
0.530
X
0.400
0.410
0.420
0.430
0.440
Y

Fig.6

SPECIFICATION

Lamp

This invention relates to a high pressure sodium vapor lamp comprising an alumina ceramic inner envelope, and more particularly, the invention relates to a high pressure sodium vapor lamp wherein an inner arc tube is provided with a pair of thermionic electrodes at least one of which as affixed thereto an oxygen getter which maintains the color rendition of the lamp.

High pressure sodium vapor lamps have found widespread use during the past decade for commercial lighting applications, especially outdoor lighting. Such lamps are described in U.S. Patent No. 3,248,590 - Schmidt, High Pressure Sodium Vapor Lamps. High pressure sodium lamps typically comprise a slender tubular inner envelope of a light transmissive refractory oxide material resistant to sodium at high temperatures, and suitably formed of a high density polycrystalline alumina. The ceramic arc tube is generally supported within an outer vitreous envelope or jacket provided at one end with the usual screw base. The electrodes of the inner envelope are connected to terminals of the base, that is to the shell and center contacts of such base. The space between the inner and outer envelopes is typically evacuated in order to conserve heat.

The color rendition of standard high pressure sodim (HPS) lamps may be improved by increasing the internal sodium partial pressure within the arc chamber of the inner envelope formed of the polycrystalline alumina. An improved color rendition of standard HPS lamps may necessitate that the polycrystalline alumina arc chamber be operated with two to three times the internal sodium partial pressure relative to conventional standard lamps. In addition, for such increased sodium pressure the wall temperature between the electrode tips within the arc chamber may be increased by 100°C relative to the standard HPS lamp in order to offset the reduction of luminous efficacy which normally accompanies operation at increased sodium pressure. An improved color rendition high pressure sodium lamp operated at two to three times typical sodium pressure is described in my copending U.S. Patent Application filed November 26, 1982 and having attorney docket No. LD 8994 which is assigned to the same assignee as the present invention.

High sodium pressures for HPS lamps are typically developed by increasing the operating temperature of the sodium-mercury amalgam reservoir typically located and thermally connected to one of the thermionic electrodes within the arc tube. As is well known in the HPS lamp art, at sodium pressures within the arc tube of two to three times higher than those for arc tubes of standard color HPS lamps, the additional pressure broadens the sodium resonance line and continuum radiations at blue and green wavelengths which effectively increases the Correlated Color Temperature several hundred degrees Kelvin, and the Color Rendition Index of the HPS lamp is thereby desirably increased up to a range of between 60 to 85.

The arc tubes of color improved HPS lamps may host undesirable sodium losses caused by chemical reactions from oxygen sources within the arc tube created by impurities undesirably introduced into the arc tube during the manufacturing process of the color improved HPS lamps. These undesirable impurities typically have undesirable results on lamp performance as manifested by an increased voltage of the arc tube, reduced luminous efficacy of the HPS lamp, and color shift toward the red portion of the visible electromagnetic spectrum over the life of the lamp. The color shift toward red is particularly disadvantageous when the HPS lamp is used in color-sensitive interior commercial and industrial applications. Further, it has been empirically determined that improved color HPS lamps exhibit greater color shifts, primarily related to red spectral content than standard lamps for the same amount of sodium loss due to internal chemical reactions.

Undesired chemical reactions related to HPS lamp arc tubes are further described in U.S. Patent 3,485,343 of P. J. Jorgensen, issued December 23, 1969. U.S. Patent 3,485,343 describes the reaction of sodium with small amounts of oxygen and water which may be present in an arc tube, which, in turn, promotes reaction with the alumina of the arc tube resulting in an undesirable removal of free sodium from the interior of the arc tube. U.S. Patent 3,485,343 further describes the use of an oxygen getter formed from doping a metal with from about 2% to 20% by weight of a cation metal having a plus four valence such as a 90% yttrium, 10; thorium alloy. The yttrium-thorium alloy oxygen getter is a relatively expensive material. It is considered desired that an oxygen getter of a relatively inexpensive material be provided so that the undesirable chemical reactions that affect the desired color rendition may be eliminated in a relatively inexpensive manner.

Accordingly, an object of the present invention is to provide means for improving the color rendition of the HPS lamps such that color shift thereof typically caused by undesirable chemical reactions between the sodium dose and oxygen sources undesirably contained within the arc tubes thereof is reduced.

A further object of the present invention is to provide means for reducing the undesired chemical reactions for the improved color HPS lamps such that a desired Color Rendition Index remains substantially constant over the life of such lamps.

These and other objects of the present invention will become apparent upon consideration of the following description of the invention.

This invention is directed to improve color rendition high pressure sodium lamps having an oxygen getter for reducing the sodium losses typically created within the arc tubes of such lamps.

Accordingly, in one embodiment of the present invention, an improved color rendition high pressure metal vapor lamp comprising an outer vitreous envelope and an arc tube contained within the outer envelope. The arc tube has sealed therein a pair of thermionic electrodes. The arc tube contains a

charge of vaporizable metal having a sodium partial pressure in the range of approximately 100 to 400 torr and xenon gas in the range of approximately 10 to 400 torr. The arc tube further has an oxygen getter which is affixed to at least one of the thermionic electrodes. The oxygen getter is a metal selected from the group of zirconium, vanadium, titanium, yttrium, and thorium metals and alloys thereof excluding yttrium.

The present invention will be further described by way of example only with reference to the accompanying drawings in which:-

Figure 1 is a front elevation view of a high pressure sodium vapor discharge lamp according to the present invention.

Figure 2 is an exposed sectional view, in a slightly enlarged manner, of the arc tube of Figure 1 in accordance with one embodiment of the present invention.

Figure 3 is an exposed sectional view, in a slightly enlarged manner, of the arc tube of Figure 1 showing another embodiment of the present invention.

Figure 4 is a high pressure sodium (HPS) lamp partially broken-away so as to show a double wire arc tube.

Figure 5 is an exposed sectional view of the arc tube of the HPS lamp of Figure 4.

Figure 6 is an International Commission on Illumination (I.C.I.) chromaicity diagram showing a typical improvement of the color temperature of the HPS lamp realized by the present invention.

A high pressure sodium vapor lamp 10 embodying the present invention and corresponding to a conventional 250 watt size lamp is illustrated in Figure 1. A high pressure sodium (HPS) vapor lamp generally comprises a vitreous outer envelope 12 with a standard mogul screw base 13 attached to the stem end which is shown uppermost in Figure 1. A reentrant stem press 14 supports a pair of relatively heavy lead-in conductors 15 and 16 extending through the stem 14 and having outer ends connected to the screw shell 17 and eyelets 18 of the base.

The HPS lamp 10 includes an inner envelope or arc tube 19 centrally located within the outer envelope 12. The arc tube 19 is comprised of a length of light-transmissive ceramic formed of a polycrystalline alumina ceramic which is translucent. The arc tube 19 contains a charge of vaporizable metals having a sodium partial pressure in the range of approximately 100 to 400 torr and a xenon gas in the range of approximately 10 to 400 torr.

The upper end of the arc tube 19 is closed by an alumina ceramic sealing plug 20 through which extends hermetically a niobium inlead 21 which supports an upper electrode (shown more clearly in Figures 2 and 3 to be described) within the arc tube 19. Similarly, the lower end of the arc tube 19 has a closure which comprises a ceramic sealing plug 22 through which extends a thin walled niobium tube 23. The ceramic sealing plugs 20 and 22 are described in greater detail in U.S. Patent 4,065,691 - McVey, Ceramic Lamps Having Electrode Supported by Crimped Tubular Inlead. The niobium tube 23 serves both as an inlead for arc tube 19 and as a reservoir for storing excess alkali metal and mercury contained within the arc tube 19. The shank of the lower electrode (shown in Figures 2 and 3 to be described) of arc tube 19 projects into reservoir tube 23 and is locked in place by crimping the niobium reservoir tube about the lower electrode at location 24 as shown in Figure 1.

The arc tube 19 of HPS lamp 10 of Figure 1 and a double wire arc tube 62 of a HPS lamp 60 of Figure 4 both to be described hereinafter, are of substantial interest in respect to the present invention. More particularly, for one embodiment of the present invention the arrangement of oxygen getters 40 and 42 about the electrode shanks 48 and 50 enclosed within arc tube 19 is of particular interest to the present invention and such an arrangement is shown in Figure 2.

Figure 2 shows an exposed sectional view, in a slightly enlarged manner relative to the arc tube 19 of Figure 1, of the arc tube 19. Electrodes 44 and 46 each comprise a low work function emissive material such as dibarium calcium tungstate which is formed into the windings wrapped about the electrode shanks 48 and 50 respectively.

Figure 2 further shows oxygen getters 40 and 42 of the present invention as being wrapped around electrode shanks 48 and 50, respectively. Although Figure 2 shows each of the electrode shanks 48 and 50 as having arranged oxygen getters 40 and 42, it should be noted that in accordance with the practice of this invention only one oxygen getter 40 or 42 need be arranged with either electrode 44 or 46.

The oxygen getters 40 and 42 are preferably formed of a single zirconium (Zr) metal, although other single metals such as vanadium, titanium, yttrium or thorium are also applicable. Further, oxygen getters 40 and 42 may also be an alloy formed from combinations of the zirconium, vanadium, titanium and thorium metals. The oxygen getters 40 and 42 formed of selected metals chemically react with oxygen gas sources during lamp operation to prevent oxygen reaction with sodium in the sodium-mercury amalgam.

The oxygen getters 40 and 42 are shown in Figure 2 in a wire wrapped manner about electrode shanks 48 and 50. The oxygen getters 40 and 42 can alternatively be placed around electrode shanks 48 and 50, respectively, in a sheet-like form.

A second embodiment of the present invention is shown in Figure 3. Figure 3 is similar to that shown for Figure 2 and uses the same reference numbers where applicable. The difference between Figure 2 and Figure 3 is that the oxygen getter related to the electrode shank 50 is located within the niobium reservoir tube 23 and has the reference number 52 as shown in Figure 3. Although not shown in Figure 3, the practice of this invention contemplates the placement of an oxygen getter within the niobium reservoir tube 23 and on each of the electrode shanks 48 and 50. The oxygen getter 52 can be inserted into the niobium reservoir tube 23 in a wire-like form or roll sheet form.

A further embodiment of the present invention is a related double-wire inner arc tube 62 centrally located within a HPS lamp 60 of Figure 4 and

supported, in part, by support member 63. The double-wire arc tube 62 is shown by means of a partially exposed illustration of the HPS lamp 60 of Figure 4. The HPS lamp 60 is of type LU35 or LU50 commercially available from the High Intensity and Quartz Lighting Department of the General Electric Company. The double-wire arc tube 62 is shown more clearly in Figure 5.

Figure 5 shows the arc tube 62, preferably formed of a polycrystalline alumina, as having two oppositely located inleads 64 and 78 formed on niobium wire.

The inlead 78 passes through and is supported by sealing plug 80. The inner portion of inlead 78 labeled 82 is connected to a shank 86 by a butt weld 84. The inner portion 82 of inlead 78 is a niobium feedthrough for arc tube 62. The shank 86 is formed of a tungsten material and has electrode coils 88 having an emission mix between its turns. The emission mix can be of a dibarium calcium tungstate material.

The inlead 64 passes through and is supported by a ceramic sealing plug 66. The inner portion of inlead 64 labeled 68 is connected to a shank 72 by a butt weld 70. The inner portion 68 of inlead 64 is a niobium feedthrough for arc tube 62. The shank 72 is formed of tungsten and has electrode coils 74 similar to the electrode coils 88.

Figure 5 shows an oxygen getter 76 wrapped around the niobium feedthrough 68 and shank 72. Although not shown in Figure 5, an oxygen getter may also be wrapped around the niobium feedthrough 82 and shank 86 both related to the niobium inlead 78. The oxygen getter 76 is of the same metal previously described for oxygen getters 40, 42 and 52.

In order that the present invention may be fully appreciated, reference is now made to comparative test data obtained between HPS lamps having improved but progressively decaying color rendition and HPS lamp 60 of Figure 4 having the double wire arc tube 62 of Figure 5 of the present invention which has an improved color rendition maintained by the oxygen getters of the present invention.

A total of 20 color improved 35 watt HPS arc tubes of double wire design were constructed and tested in accordance with the practice of this invention. The arc tube chambers of the 20 HPS lamps had an inner diameter of 4.5 mm and an arc-gap, that is, the spacing between the thermionic electrodes, of 12.0 mm. The (20) color improved 35 watt HPS arc tubes were dosed with 10 milligrams of 25% by weight sodium-mercury amalgam a xenon starting gas at a pressure of 15 torr at room temperature. The thermionic electrodes of the 20 arc tubes were activated with a dibarium calcium tungstate so as to improve the thermionic emission of the electrodes. The group of 20 HPS lamps were then divided into twelve (12) HPS lamps 60 according to the present invention having oxygen getters 76 and eight (8) HPS lamps not having an oxygen getter.

Two oxygen getters 76 for each of the twelve (12) HPS lamps 60 of the present invention were formed by a single turn of 0.020 zirconium wire and each oxygen getter 76 was wrapped about the base of each electrode shank in a manner similar to that shown in Figure 5 for oxygen getter 76 and located between the electrode coils 74 and 88 and ceramic end plug 66 and 80. The group of twelve (12) arc tubes 62 of the present invention and the eight (8) arc tubes not having the advantages of the present invention were made into finished lamps and then photometered. All twenty (20) of the finished lamps had an initial Correlated Color Temperature of approximately 2200°K and Color Rendition Index of 75.

All 20 HPS lamps were operated for a total of 500 hours at an operating wattage of 35 watts. The results of the 500 hours of operation of the twenty (20) HPS lamps are best described with reference to Figure 6.

Figure 6 is a portion of the International Commisson on Illumination (I.C.I.) chromaticity diagram well known in the HPS lamp art. the X axis shown in Figure 6 with locations of 0.490, 0.500, 0.510, 0.520 and 0.530, and the Y axis of Figure 6 with locations 0.400, 0.410, 0.420, 0.430 and 0.440 form a coordinate system by which changes in lamp Correlated Color Temperature over a duration of time may be illustrated. Figure 6 shows a curve 90 representative of an ideal black body such as substantially achievable from an incandescent light source. Figure 6 shows this black body curve 90 as intersected by a plurality of Correlated Color Temperature lines of 2000°K, 2065°K, 2200°K, 2230°K, 2400°K and 2600°K.

The 20 HPS lamps before being subject to the 500 hours of testing had an initial Correlated Color Temperature of approximately 2200°K, a color rendition index of 75, and a location 92 shown in Figure 6. Location 92 of Figure 6 is located along the 2200°K Correlated Color Temperature line and at a position just below but very near the ideal black body curve 90.

After subjecting the 20 HPS lamps to the 500 hours of testing, the twelve (12) improved color rendition lamps 60 of the present invention were determined to be advantageously shifted from the Correlated Color Temperature of Location 92 to a Correlated Color Temperature of location 94, and conversely, the eight (8) color improved HPS lamps not having the oxygen getter 76 of the present invention were determined to have an undesirable shift downward in Correlated Color Temperature from location 92 to location 96, both of Figure 6. The undesirable shift of the HPS lamps not having the advantages of the present invention is toward the red portion of the visible electromagnetic spectrum, and conversely, the desirable shift of the HPS lamps of the present invention is away from the red portion of the visible electromagnetic spectrum. The advantageous shift of the 12 HPS lamps of the present invention is shown, in phantom, in Figure 6, by an arrow 98, and, similarly, the undesirable shift of the HPS lamps not in accordance with the present invention is shown, in phantom, in Figure 6 by an arrow 100.

All of the twelve (12) HPS lamps 60 of the present invention and the eight (8) lamps not having the teachings of the present invention were physically examined after the 500 hours of testing. The twelve (12) HPS lamps 60 of the present invention exhibited arc chambers ends that were noticeably cleaner

relative to blackened ends of the HPS lamps which did not embody the present invention. The noticeably cleaner arc chamber ends of the arc tube 62 of the present invention is beneficial with regard to the efficacy and maintenance of the HPS lamps 60.

It should now be appreciated that the practice of the present invention provides an improved color HPS lamps 60 and 10 having improved maintenance of high color temperature. The improvement of maintenance of high color temperature is achieved by the oxygen getter of the present invention. It should be noted that although the comparative data was related to 35 watt HPS lamps, the present invention contemplates HPS lamps having much higher wattage such as 1000 watts and conversely having much lower wattage such as 15 watts.

CLAIMS

1. An improved color rendition high pressure metal vapor lamp comprising:
an outer vitreous envelope;
an arc tube contained within the outer envelope and having sealed therein a pair of thermionic electrode structures, said arc tube containing a charge of vaporizable metals having a sodium partial pressure in the range of approximately 100 to 400 torr and a xenon gas in the range of approximately 10 to 400 torr, and an oxygen getter affixed to at least one of said thermionic electrode structures of said arc tube, said oxygen getter consisting of a metal selected from the group of zirconium, vanadium, titanium, yttrium and thorium metals, and alloys thereof excluding yttrium.

2. A lamp as claimed in claim 1 wherein one of said pair of thermionic electrode structures is connected to a tube serving as a reservoir for storing an excess of alkali metal contained within the said arc tube and has disposed therein another oxygen getter being a metal selected from the same group of metals and alloys of said first mentioned oxygen getter.

3. A lamp as claimed in claim 2 further comprising an additional oxygen getter affixed to the other thermionic electrode structure of said arc tube, said additional oxygen getter being a metal selected from the same group of metals and alloys of said first mentioned oxygen getter.

4. A lamp as claimed in claim 2 or 3 further comprising an additional oxygen getter affixed to the other thermionic electrode structure of said arc tube, said additional oxygen getter being a metal selected from the same group of metals and alloys of said first mentioned oxygen getter.

5. A lamp as claimed in claim 1 wherein said thermionic electrode structures each further have a niobium inlead extending into said arc tube and provided for connections external to said arc tube, the other thermionic electrode structure of said arc tube having affixed thereto another oxygen getter being of a metal selected from the same group of metals and alloys of said first mentioned oxygen getter.

6. A lamp as claimed in claim 1 substantially as herein described with reference to and as illustrated in the accompanying drawings.

Printed in the UK for HMSO, D8818935, 8/84, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.